PSEUDOBONELLIA, A NEW ECHIUROID GENUS FROM THE GREAT BARRIER REEF.

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(Plates ix.-xi.)

Very little appears to be known regarding Australian Echiuroids, although one genus, *Thalassema*, is well represented on the Queensland coast. We have collected specimens on many of the mud-sand flats in Moreton Bay (Myora, Amity, Swan Bay, Goat Island, Southport), where it is fairly common, being in places very abundant. This is the species referred to by Tosh (1902, p.180, Pl.12, fig.3). A related and perhaps identical species occurs in similar situations at Burnett Heads. Other species are represented in collections made by us from beneath stones and dead coral in Moreton Bay (Peel and Goat Islands); Port Curtis (Facing, Rat, and Curtis Islands); and on the Capricorn Reefs (Masthead and North-west Islets). A species is occasionally met with in Port Jackson, having been recorded by Whitelegge (1889, p.211) as *Thalassema* sp.

Shipley (1899) reported the presence of a number of species in New Guinea and adjacent islands lying to the north-east of Australia, mentioning other Eastern Pacific forms as well. Sluiter (1891, 1902) recorded a considerable number from the Dutch East Indies, while Ikeda (1904, 1907) gave an account of several of those occurring in southern Japanese waters. The genus is, then, well represented on the tropical and subtropical coasts of the Eastern Pacific.

Echiurus and *Hamingia* are represented each by one species—*E. unicinctus* Drasche, from the cold waters of northern Japan (Selenka, 1885, p.6; Shipley, 1899, p.344), and *H. sibogæ* Sluiter (1902, p.44) dredged by the Siboga Expedition from the very deep water in the East Indies.

We are aware of only one record of the occurrence of *Bonellia* or Bonellia-like echiuroids on the Queensland coast, Hedley (1906, p.462) having stated that he saw *Bonellia* in abundance in the lagoon in Masthead Islet, Capricorn Reefs. Only on one occasion (August, 1917) have we succeeded in finding a few specimens of a Bonellia-like worm in that locality, though searched for on several occasions between 1912 and 1917. He also made reference (1906, p.462; 1915, p.27) to the attempts of tropical animals such as *Bonellia* to colonise the shores of New South Wales while the Notonectian current floods the coast, many such perishing when this warm stream swings off-shore. This, no doubt, is the explanation of the occasional presence of a number of tropical invertebrates in Port Jackson.

Haswell (1885, p.331) reported the presence in Port Jackson of a *Bonellia* which he identified as *B. vividus* (a misprint for *B. viridis*, the Neapolitan species), mentioning, however, that there were certain differences from that species in regard to the reproductive organs. His specimen came from Neutral Bay. Whitelegge (1889, p.211) quoted the reference under *Bonellia* sp., and added another locality in Sydney Harbour, viz., Mosman Bay. Mr. Whitelegge informed us that he had obtained his from under a stone at Sirius Cove, Mosman, during a low tide.

Saville-Kent (1889, p.230) reported that *Bonellia* was obtained in abundance while dredging in the Cambridge Gulf, North-West Australia, while Dakin (1916, p.23) recorded the occurrence of a green species on the Abrolhos Islands, the Swan Estuary, and off Garden Island (near Fremantle) in South-Western Australia.

Shipley (1899, p.336) referred a small specimen found by Willey in the Loyalty Islands to the species *B. viridis*, mentioning (p.342) that the latter had noticed the same species in the D'Entrecasteaux Group, British New Guinea. Sluiter (1902, p.50) expressed the opinion that a detailed examination of the worms identified as *B. viridis* by Shipley and by Haswell would probably show that the Pacific species was distinct.

B. pumicea Sluiter (1891, p.111) occurs in the Dutch East Indies, while from Southern Japanese waters Ikeda (1904, 1907) has identified *B. minor* Marion, *B. miyajimai* Ikeda, and *B.*

misakiensis Ikeda. The known distribution of *B. minor* is remarkable, viz., Mediterranean (Bay of Naples and Marseilles) and the Loochoo (Riukiu) Islands, off Formosa. Ikeda, however, refers (1904, p.72) to certain differences in regard to the anal vesicles, so that it is not improbable that he was dealing with a distinct though closely related species.

Pseudobonellia biuterina, n.gen. et sp.

During a visit in August, 1915, to North-West Islet, and in 1917 to Masthead Islet, two of the Barrier Reef atolls belonging to the Capricorn Group, situated due east from Keppel Bay, Queensland, some remarkable echiuroids were found which, from their external appearance, were then regarded as a small species of *Bonellia*, but subsequent examination showed anatomical differences of such a nature that it has been deemed necessary to propose a new genus for their reception. In general appearance, size, and colour, they remind one of the Japanese *B. minor*. They have, moreover, a similar habit, occurring between tide-marks on the coral reef flats and in boulders, with the dark green body hidden in crevices in the dead coral, from which the rather more lightly-coloured, bifurcated proboscis can be protruded for a considerable distance.

The size of the female varies within rather wide limits, due, no doubt, to differences in age. In specimens preserved in formalin, the body length ranged from 1·5 to 2·6 cm. and the breadth from 0·4 to 0·8 cm. Accurate measurements of the living proboscis were not made, but the organ was capable of extension to about 10 cm. In preserved material it varied in length from 1 to 3 cm., while the bifurcations reached from 0·4 to 2 cm. according to the degree of contraction.

The body is somewhat sack-like, broader posteriorly than in front (Plate ix., figs.1, 2). The groove on the ventral surface of the proboscis is broad and shallow distally, becoming deeper and more prominent as it approaches the mouth. At about 2 mm. behind the latter lie the ventral setæ. The external openings of the uteri were not recognisable in entire specimens, but in one out of twenty-six worms examined, there was to be seen a dis-

tinct pit, from the floor of which a definite papilla arose. In section, the apertures were seen to be quite small, and situated on the general body surface a short distance behind the setæ. The body is covered with small, flat-topped papillæ, closely arranged, being separated from each other by well-marked, narrow furrows. As a result of the bleaching of the bonellin pigment during preservation, the body wall was rendered fairly transparent, and the twisted intestine, with its mass of white granular contents, could be plainly seen.

The body wall.—Dorsally the body wall is very thin, while ventrally it is very much thicker, owing to the greater development of the musculature in that region. On the outside, next to the very thin cuticle, is an epidermis consisting of a single layer of columnar cells, below which lies the well-developed dermis with highly vacuolated connective tissue, traversed by fibres arranged vertically to the surface of the body. Abundant, branching, gland cells which stain deeply with hæmatoxylin are lodged in the dermal portion of each papilla and open through the epidermis (Plate x., figs.8, 9). These glands, no doubt, are responsible for the production of the mucous secretion which gives a slimy consistency to the preservative (formalin), from which it is readily precipitated by the addition of alcohol. Below the dermis are three series of muscles, an outer circular, a middle longitudinal, which is about twice as thick as the preceding, and an inner oblique layer (inner circular layer of Sluiter, 1891) whose fibres travel partly circularly and partly obliquely. The last series is about half as thick as the outer circular musculature. The longitudinal layer is not divided up into separate bundles. The appearance of the body wall in section reminds one of that figured for *B. pumicea* by Sluiter (1891, Pl.1, fig.2).

In the proboscis, the first and second series alone are present. The circular layer is well-developed, but it is the longitudinal system which occupies the greater part of the organ (Plate ix., fig.6). The latter musculature consists of two sets of fibres, an outer composed of abundant, closely-arranged, small fibres, and an inner mass consisting of a great number of large fibres, well separated from one another by connective tissue when the organ

is in a contracted state. The dermis of the proboscis is relatively thin and has a loose texture.

Setæ.—The setæ are rather prominent chitinous structures, situated ventrally, about 2 mm. behind the mouth in large specimens, and projecting downwards and slightly outwards in preserved animals. They vary in number from two to four, fourteen out of twenty-one specimens showing two setæ, three showing each three setæ, while the other four each had four. Since, with one exception, it was the larger forms that had the four setæ, of which one pair was always larger than the other, it would appear that the smaller setæ were in process of replacing the larger. Each seta is a flat, blade-like structure (Plate ix., fig.3), hooked at the free end, the larger type measuring from 2 to 3 mm. in length, the smaller 0·7 to 0·8 mm. Each lies in a deep setigerous sac, projecting far into the body of the worm, and ending internally close beneath the œsophagus. The setigerous sac is merely an invaginated part of the body wall, but the epidermal cells at its base are considerably elongated, and in longitudinal section have a fibrous appearance. The sac of each smaller seta is developed independently of, but in close connection with, that of a larger seta.

Connected with the setæ is a powerful musculature. A strong, transverse muscle pad joins their internal ends, evidently serving to impart to them a lateral pincer-like movement, while a number of muscles, attached internally to the ends of the setæ and externally to the body wall, evidently serve to move them backwards and forwards, probably at the same time acting as protractors.

Cœlome.—The body cavity is well-developed, but in places is more or less fully occupied on account of the great development of the intestine (Plate x., fig.9). It is lined by a delicate peritoneum. Anteriorly, in the region of the setæ, it gives off two inward projections between the setigerous musculature, these travelling forwards on either side of the pharynx to enter the proboscis, at the end of the bifurcations of which they turn sharply backwards and inwards to meet one another. This could be made out in serial sections. Each cœlomic extension was associated with a lateral bloodvessel (Plate ix., fig.6).

The Alimentary Canal.—The mouth is a wide ventral opening at the junction of the body and proboscis. Behind, the buccal cavity leads into a muscular pharynx that becomes continuous with the irregularly coiled intestine, which in a specimen whose body was about one inch long, was found to measure about four inches in length (Plate ix., fig.2). The intestinal contents are arranged in oval pellets, probably by the muscular pharynx in which food was seen to lie in a loose mass.

The intestine is a rather thin-walled tube, consisting of a very thin internal layer of circular muscle next to the enteric epithelium, and surrounded by a slightly thicker layer of longitudinal muscle. On the ventral region of the alimentary canal the enteric epithelium is seen to be especially prominent anteriorly where the wall is thick, such modified structure being, however, limited to about one quarter of the circumference of this portion of the gut. Somewhat more posteriorly, where the intestine is wider but thinner-walled, this modified part is much more extensive, occupying at times about three-quarters of the circumference of the ventral and lateral walls, but the layer is then much less prominent. It appears to consist of a glandular epithelium, and stains deeply with hæmatoxylin. No doubt the structure is homologous with the ventral bandelette of some French authors.

Along its whole length the canal is attached to the body wall by thin, muscular strands or "mesenteries," more prominent posteriorly than anteriorly (Plate x., fig.9). They are much less numerous than those generally figured for *B. viridis*. A peritoneum lines the cœlomic surface of the intestine.

Lying dorso-laterally to the anterior region of the intestine is a siphon, a delicate tube about 5 mm. long, in close connection with the intestine, having in places a very narrow, compressed bore, but whose lumen, in most parts, is wholly obliterated. No definite opening into the pharynx exists. The siphon arises as a thickening on one side, more or less dorsally, soon becoming distinct from the pharyngeal wall, but remaining in close association with it, being separated merely by a very narrow, membrane-like tissue. After maintaining contact for some distance, it

eventually comes to lie freely in the cœlome in the vicinity of the anterior parts of the uteri, but ultimately coalesces with the dorso-lateral wall of the intestine, the area of union being elongate and slit-like, with greatly folded walls (Plate x., figs.10, 11). The lumen of the folded portion is narrow, and the epithelium contains abundant gland cells like those of the intestine. This structure does not appear to be represented in *Bonellia*.

Nervous System.—The nervous system consists of a ventral nerve cord and a circum-œsophageal ring. The former lies mid-ventrally within the body cavity, attached to it by a short mesentery. About 25 pairs of nerves are given off to the body wall (Plate ix., fig.4). Ganglia are absent. Anteriorly at the base of the setæ the cord bifurcates, the two portions coming to lie at the sides of the muscular pharynx, and being included in the outer longitudinal layer of muscle, *i.e.*, they lie in the body wall. The two branches then travel along on either side of the proboscis, and, entering the bifurcation, proceed to the end, then turn back sharply, meeting one another so as to form an enormously elongated circum-œsophageal nerve ring (Plate ix., fig.5). Associated with the median bloodvessel of the proboscis, especially on its ventral aspect, is a mass of tissue which appears to be nervous (Plate ix., fig.6).

Vascular System.—There is a ventral bloodvessel, which travels in the body cavity immediately above the ventral nerve cord to which it is attached by a delicate membrane (Plate xi., fig.18). Posteriorly, at about the middle of the body, it dilates, and, leaving the ventral nerve cord, passes upwards to become applied to the nearest coil of the intestine. In this region, and to a less extent in other places more anteriorly, large numbers of colourless corpuscles can be detected. Posteriorly, the lumen of this dilated vessel appeared in section to be more or less occupied by a spongy mass resembling connective tissue, but which may have been coagulated fluid. Corpuscles were present entangled in it. The vessel travels backwards in close connection with the more dorsal portion of the intestine (serving evidently as a food-absorbing organ) till it gradually disappears. The condition is similar to that described by Spengel (1879) as occurring in *B.*

viridis. Anteriorly in the region of the setæ, the ventral vessel is much narrower. Between the setæ, it passes vertically upwards and then bifurcates, the branches passing around the œsophagus in whose muscular walls they lie; they enter the proboscis, and, passing forwards in close connection with the corresponding proboscis nerve to which they each lie ventrally, travel to the anterior end (Plate ix., fig.5). Still closely associated with the nerve, they each enter a bifurcation of the proboscis, to the extremity of which they extend, then turn back, meeting in the middle to complete the circum-œsophageal vessel. Along their whole length they are suspended in the prolongations of the cœlome already described. From the mid-dorsal region of the circum-œsophageal vessel a dorsal bloodvessel is given off, travelling down the middle of the proboscis surrounded by a tissue which, as already stated, appears to be nervous. This dorsal vessel breaks up into capillaries in the vicinity of the œsophagus.

Anal trees.—The anal glands or posterior nephridia are represented by two small, tuft-like masses situated one on each side of the posterior end of the intestine (Plate ix., fig.7). Each consists of a mass of very delicate, simple, cylindrical tubes opening separately into the rectum, whose walls in this region are thickened, while rather prominent ridges of tissue project into its lumen, giving the tube a star-like appearance in section. This is perhaps due to the presence of well-marked circular (sphincter) and longitudinal bundles of muscle fibres. The tubules are approximately circular in section with an irregular lumen. They consist of a single layer of elongate epithelial cells. Near its free end each tubule becomes narrowed before opening into the cœlome by a slightly dilated funnel fringed with long cilia (Plate x., figs. 13, 14, 15). The nephridia thus differ from those described in various species of *Bonellia*, in that the funnels are simple, unbranched tubes which open directly into the rectum, instead of into a large vesicle on each side.

The Ovary. - The mesenteric strands of muscular tissue which maintain the posterior portion of the rectum in position are very well developed and form the basis of the ovary (Plate ix., fig.2),

whilst from the peritoneum lining them the ova are developed. The organ is slightly elongate transversely, and lies ventrally and laterally from the rectum. It thus has a position different from that described for *Bonellia*, where its main axis is longitudinal.

Spengel (1897, pp.360-373) gave a detailed account of the early development of the ova of *B. viridis*. We were not able to observe the early stages, while the later ones are different from those described by him. He gave an account of characteristic cell masses developing from the peritoneum lining the ventral bloodvessel, and forming each a spherical mass consisting of a relatively large central cell (which degenerates later) surrounded by a layer of small peripheral cells. It is from one of the latter that, according to him, the ovum develops at the expense of the remainder.

In our specimens the earliest stage observable shows this cell mass in its nine-celled condition, there being a slightly differentiated central cell present (Plate x., fig.16*a*). It is this latter cell that develops into the ovum. The cell mass grows quickly, the central cell outstripping the others, which become cubical and form a membrane, at first thick and closely fitting, but later thin and far separated from the central cell (Plate x., figs.16*b-e*). In these later stages, the central egg-cell can be seen to be actually connected by a stalk to the mesenteric strands. As the egg grows larger, it fills the space within the ring of accessory cells; and, continuing to grow, stretches this layer, which eventually comes to lie as a delicate membrane around the egg. The latter is now fully developed. At this stage the stalk evidently ruptures and the egg escapes. Within the cœlome, eggs may be seen with the small peripheral cell nuclei on their surface.

The ova pass forward and are received into the uteri. The peripheral egg membrane has by this time disappeared. In *Bonellia*, according to Spengel, it bursts before reaching the uterus. The eggs in the uteri are large cells, each with a prominent nucleus. They measure about 0·11 mm. in diameter, while the nuclei are about 0·037 mm. across. The latter contain large numbers of nucleoli. The egg cytoplasm is faintly granular,

containing an outer clearer portion which is sometimes slightly and sometimes very highly vacuolated.

Anterior nephridia (*uteri*). There is a pair of uteri which, in the mature state, when laden with ova, are very prominent, projecting upwards and backwards from the anterior end of the ventral body wall (Plate ix., figs.2, 4). They are about 6 mm. in length, cylindrical in the middle, but tapering to a blunt point at the extremities. Each communicates with the cœlome by a nephrostome, borne at the end of a relatively thick tube which opens into the uterus ventrally, close to the posterior end (Plate x., fig.12). The rim of each nephrostome is prominent and is distinctly crenate. The proximal end of the tube projects slightly into the uterine cavity (Plate x., fig.9). Perhaps this arrangement serves as a means for preventing the return of eggs to the cœlome. In Plate x., fig.9, one may see this proximal invaginated portion in section lying within the uterine cavity.

Uteri from which eggs are absent are cylindrical; and in cross-section the lumen can be seen to be occupied by a meshwork of connective tissue trabeculæ which almost obliterate it in places. It is in this connective tissue that the eggs come to lie imbedded singly (Plate x., fig.9). Each uterus consists of an outer mass of tough connective tissue containing longitudinal muscle fibres. Internal to this is a highly developed, readily staining, glandular layer. The external uterine openings are close to one another on the ventral body wall, about 3 mm. behind the mouth.

Male tube (*andrœcium*).—As in *Bonellia* and *Hamingia*, the male is very degenerate. It is not, however, lodged in the œsophagus, uterus, or body cavity, as in these genera, but lives within a definite blindly-ending tube projecting into the cœlome, and opening on the ventral body wall between the two uterine apertures by a narrow muscular canal whose walls contain strong sphincter fibres. This remarkable structure we propose to call the *male tube* or *andrœcium*. Internally it is lined by a cubical epithelium, continuous through the aperture with the columnar epithelium of the body wall. The walls of the organ consist chiefly of the invaginated dermis and epidermis, but there is also a slight development of an inner circular and an outer longi-

tudinal muscle layer, continuous with the corresponding muscle layers of the body wall. The oblique muscle layer is absent.

Male.—The male is an extremely degenerate, elongated organism which in transverse section may appear almost circular or nearly semi-circular. It is about 0·6 mm. in length and 0·12 to 0·16 mm. in maximum breadth. The anterior end appears more or less spherical, this portion being followed by a somewhat constricted region, the remainder of the worm being cylindrical, with a diameter approximately equal to that of the anterior portion. There are no ventral setæ. The epidermis on the anterior portion of the male is cubical; but posteriorly its cells are very elongated to form a prominent structure. In the mid-region of the body the cells are of an intermediate character.

Below the epidermis lies a thick mass of dermis ("trabecular layer" of Ikeda; "parenchyma" of Spengel) of a rather loose texture, surrounding the cœlome. It contains abundant lacunæ. In the posterior portion of the organism there is a definite system of longitudinal muscle fibres (subperitoneal musculature of Ikeda, 1907) lying in the dermis, close to the cœlome. They can be best distinguished in longitudinal section. In immature males the cœlome is practically obliterated, but in mature forms it is well developed, and may be divided into a small but almost spherical portion at the anterior end of the organism, joined by a very narrow canal with an elongated but not so dilated posterior part. No peritoneum could be detected lining the body cavity except the anterior dilatation.

The anterior portion of the cœlome lodges the sexual organs, alimentary canal and nerve. The last-named is very ill-defined, occurring as a slight prominence mid-ventrally, projecting into the cœlome from the ventral body wall. Nothing could be made out regarding its structure. It appears to be absent from the posterior part of the animal.

The alimentary canal is also extremely rudimentary, mouth and anus being absent. It lies in the front portion of the anterior dilatation of the cœlome, being recognisable as a short, vesicular, rudimentary structure with a rather definite lumen, and about 0·03 mm. in length. Its wall consists of comparatively

large, clear cells, having pseudopodial processes projecting into the lumen in a manner somewhat like that figured by Ikeda (1907, p.10, Pl.2, fig.17). The digestive tract in *Pseudobonellia* appears to be the most degenerate so far known to occur in *Bonelliidæ*, as it consists of a minute spheroidal body, reminding us of one of the fragments figured by Ikeda (1907) in the male of *B. miyajimai*, in which there occur a large number of separate closed vesicles floating in the body cavity.

A few, highly-refracting, rounded cells are constantly present in the cœlome, and are probably to be regarded as representing chlorophyllous cells such as are described from the male of *B. viridis*. The posterior nephridia could not be detected, owing, at least in part, to the extremely small size of the organism.

The greater part of the remainder of the anterior part of the body cavity is filled with sexual elements. Two vesiculæ seminales occur. These are very short, prominent vesicles, or rather spheres, usually so dilated with mature sperms that it is impossible to make out the structure of their extremely thin walls. From the inner side of each of these vesiculæ, a very delicate short vas deferens is given off, travelling forwards and outwards to open independently to the exterior ventro-laterally at a little distance behind the anterior extremity.

The sperms are minute, tailed cells, with rod-like heads. Their formation is different from that of the ova; similar masses of central ("spermatophores") and peripheral cells are formed, but they lie in the anterior dilatation of the body cavity. Sperms do not arise directly from the central cell, but by modification of the peripheral cells. The central cell does not grow very large. When the sperms are fully developed, they separate from it. Numerous "sperm spheres" can be seen within the anterior cœlomic dilatation.

It has already been mentioned that the epidermis of the posterior third or half of the male is greatly modified. The cells, instead of being small and more or less cubical, become long and irregular, with spaces between them (Plate xi., figs.23, 24). Some appear to be branched at the extremity, but this effect is probably given by the irregularities of shape of adjacent cells. The

whole of this region of the male is wedged into the end of the andrœcium in such a way that there appears to be a very intimate relationship between the two, amounting practically to a fusion. The epithelial cells lining the andrœcium are squames of about one-half the thickness of those lining the male body. These squames at the line of junction of the male and its tube become reflected over the male for a little distance, so that in section one sees a layer of cells of female origin, *i.e.*, those from the wall of the andrœcium, actually lying outside of, and closely adjacent to, the epithelium of the male. This is well shown in the oblique section figured on Plate xi., fig.23, where one part of the male is seen to be imbedded in the dermis of the andrœcium, while the remainder is enveloped by the epithelium of the latter, enclosing a part of the cavity of the male tube. Short finger-like prolongations of this cavity are also seen in section.

Here, then, is a most remarkable association between the sexes. Not only is the male a parasite as it is in *Bonellia*, but it lives in a special compartment lying between the two uteri. In *Bonellia* it is, moreover, a freely motile organism, while in *Pseudobonellia* the posterior half of the male becomes actually surrounded by female tissues so that the parasitism is of a very much more pronounced type. The whole of the male apparatus is lodged in the cœlome of the tiny, spherical, anterior quarter of the animal. This part is connected with the attached region by a zone whose cœlome is very narrow. The posterior region reminds us of a placenta by means of which, no doubt, the male is nourished by the female. Associated with this apparently sessile existence, there is a very poorly developed musculature, and the alimentary system is almost obliterated, while the nervous system is extremely rudimentary.

If our interpretation be correct (and it is based on a study of a number of males, both mature and immature, in whole mounts as well as in transverse and longitudinal sections), then the male of *Pseudobonellia* is an extraordinarily degenerate organism. How it performs its sexual functions is not known. Perhaps the sperms may be liberated into the cavity of the andrœcium whence they reach the exterior through its canal and enter either

of the adjacent uterine openings. It is, however, quite likely that the male may be protruded through the canal of the androecium and actually liberate sperms into the female apertures.

W. Kellicott, in his Textbook of General Embryology (1914, pp.106-7), drew attention to a series of organisms showing various grades between fully developed males and females on the one hand, and a fully developed animal of only one sex, with its partner more or less parasitic on, or in it, on the other hand; the final stage being reached in hermaphrodite self-fertilising flatworms; in other words, the sex relationship may be followed through successive stages of symbiosis and parasitism, and, perhaps, incorporation of one sex in the other (hermaphroditism). The series mentioned by Kellicott includes the following:— Certain Cirripede species in which there is a diminutive complementary male living parasitically on the hermaphrodite form; *Bilharzia*, in which the elongate female lives in a canal on the ventral surface of the male which is wrapped partly round it; the permanent fusion of two hermaphrodites (*e.g.*, *Diplozoon*) in such a way that the female duct of each becomes continuous with the male canal of its partner; or the fusion of a male and a female, *e.g.*, the gape worm of poultry, *Syngamus;* while an extreme type is to be found in another parasitic nematode, *Trichosomoides crassicauda* where the female harbours one or more males in its uterus. He goes on to state that one might say that the true climax is reached in self-fertilising hermaphrodites.

We think that two stages between the conditions found in the last-mentioned two worms can be exemplified by *Bonellia* and *Pseudobonellia*. In *Trichosomoides*, the males, though somewhat degenerate, are provided with a definite alimentary canal extending from the anterior end to the anus. In *Bonellia*, however, the male is a ciliate, planarian-like parasite frequenting the œsophagus or uterus (or, in one case, the cœlome) of the female; but it has neither mouth nor anus, and its alimentary canal exhibits various degrees of atrophy. In other words, parasitism has gone further than in the case of the nematode. In *Pseudobonellia*, as we have already seen, degeneracy has proceeded still further, and the male is little more than a sperm-

producing apparatus partly incorporated in the female tissues. Complete fusion would produce a hermaphrodite condition, but we do not think it likely that hermaphroditism would arise in that way, since the male system would require to retain at least a part of its own nerve system for its innervation.

The outstanding features of the remarkable species now described may thus be summarised :—*Female:* Bonellia-like form; the presence of two to four setæ; two well developed and functional uteri; simple anal glands opening directly into the rectum, *i.e.*, there are no definite anal vesicles; posterior transverse position of ovary; a siphon associated with the intestine; presence of an invagination (andrœcium or male tube) within which only one male is lodged. *Male:* extremely degenerate and apparently partly fused with the female; possessing two functional vesiculæ seminales; hooks absent. Such features are of sufficient importance to justify the erection of a new genus, *Pseudobonellia*, within the family *Bonelliidæ*, with generic characters as above stated. Type species, *P. biuterina* Johnston and Tiegs, 1919.

The form of the body and proboscis, as well as many of its internal characters, separate the genus from *Thalassema* and *Hamingia*, but relate it to *Bonellia*; while the presence of two uteri, a male tube and a siphon in the female, and two vesiculæ in the male separate it from the last-named. The absence of hooks or ventral setæ in the male has been noted in the case of some species of *Bonellia*, while the presence of more than two in the female has been recorded in the case of one species, viz., *B. miyajimai*, by Ikeda (1907, p.3, Pl.2, fig.6), who reported the occurrence of no less than twenty-nine small ones.

Typical specimens of *P. biuterina* are being deposited in the Australian Museum, Sydney, and the Queensland Museum, Brisbane.

LITERATURE.

Dakin, W. J.—The Marine Biology of West Australia. Proc. Roy. Soc. West Aust., i., 1914 (1916), pp.11-27. See also Journ. Linn. Soc. Lond., xxxiv., 1919, p.175.

Haswell, W. A.—An Australian species of *Bonellia*. Proc. Linn. Soc. N. S. Wales, Ser. 1, x., 1885, pp.331-2.

Hedley, C.—The Mollusca of Masthead Reef. Proc. Linn. Soc. N. S. Wales, xxxi., 1906, pp.453-479.

———————An Ecological Sketch of Sydney Beaches. Proc. Roy. Soc. N. S. Wales, xlix., 1915, pp.15-77.

Ikeda, I.—The Gephyrea of Japan. Journ. Coll. Sci. Univ. Tokyo. xx. (4). 1904.

————————On three new and remarkable species of Echiuroids, etc. Journ. Coll. Sci. Univ. Tokyo, xxxi. (8), 1907.

Saville-Kent, W.—Preliminary Observations on a Natural History Collection made at Pt. Darwin and Cambridge Gulf. Proc. Roy. Soc. Queensland, vi., 1889, pp.219-236.

Selenka, E.—Report on Gephyrea. Chall. Rep., xiii., Part 36, 1885.

Shipley, A. E.—On a Collection of Echiurids from the Loyalty Islands, New Britain, etc. Willey's Zool. Results, iii., 1899, pp.335-353.

Sluiter, C.—Die Evertebraten aus d. Samml. d. K. naturw. Ver. Ned. Indie. Die Gephyreen. Natuurk. Tijd. v. Ned. Indie, l., 1891, pp.104-123.

————————Gephyrea. Siboga Expedit. Monogr., 25, 1902.

Spengel, J. W.—Beitrage zur Kenntniss der Gephyreen, etc. Mitth. Zool. Stat. Neapel, i., 1879, pp.357-419.

Tosh, J. R.—On the Common Whiting of Moreton Bay. Proc. Roy. Soc. Queensland, xvii., 1902, pp.175-184.

Whitelegge, T.—List of the Marine and Freshwater Invertebrate Fauna of Port Jackson, etc. Proc. Roy. Soc. N. S. Wales, xxiii., 1889, pp.163-323.

REFERENCES TO LETTERING.

a.g., anal glands (posterior nephridial tubes); *b.w.m.*, body wall of male; *c*, cœlome; *c.c.*, central cell; *ci*, cilia; *c.corp.*, cœlomic corpuscle; *c.m.*, circular muscles; *c.p.*, cœlomic prolongations into proboscis; *c.v.*, cœlomic opening of uterus; *d.*, dermis; *d.b.v.*, dorsal bloodvessel; *e.*, egg; *e.m.*, epithelium of male; *e.m.m.*, modified epithelium of male; *e.m.t.*, epithelium of male tube; *ep.*, epithelium; *g.c.*, gland cells; *g.l.*, glandular layer; *i.*, intestine; *i.l.*, intestinal lumen; *i.w.*, intestinal wall; *l.*, lacunæ in body wall; *l.b.v.*, lateral bloodvessel of proboscis; *l.m.*, *l.m.*1., *l.m.*2., longitudinal muscle; *l.n.*, lateral nerve of proboscis; *m.*, male; *m.a.*, one of the male apertures; *m.c.*, cœlome of male; *mes.*, "mesentery"; *m.m.*, modified body wall musculature in vicinity of a uterine aperture; *m.t.*, male tube (andrœcium); *m.t.c.*, cavity of male tube; *m.t.o.*, opening of male tube to exterior; *m.t.w.*, wall of male tube; *n.*, nerve; *neph.*, nephrostome of anal tubule; *o.*, ovum; *œs.*, œsophagus (pharynx); *o.m.*, oblique (inner circular) muscle; *ov.*, ovary; *p.*, papilla; *p.c.*, peripheral cell; *per.*, peritoneum; *r.*, rectum; *s.*, setæ; *s.b.*, sperm ball; *s.f.*, siphonal folds; *s.t.*, siphonal tube;

u.c., uterine cavity; *w.*, uterus; *u.i.*, inner part of uterus; *u.o.*, outer part of uterus; *u.u.*, funnel (nephrostome) of uterus, communicating with the cœlome; *v.b.v.*, ventral blood vessel; *v.d.*, vas deferens; *v.g.p.*, ventral groove of proboscis; *v.n.c.*, ventral nerve cord; *v.s.*, vesicula seminalis; *x.*, nervous(?) tissue associated with dorsal blood vessel of proboscis; *y.*, pit surrounding uterine openings.

EXPLANATION OF PLATES IX.-XI.

Plate ix.

Fig. 1.—Female of *Pseudobonellia hinterina:* ventral view (slightly magnified).

Fig. 2.—Female, showing anatomy (× about 3). The uteri were empty in the specimen figured.

Fig. 3.—Setæ.

Fig. 4.—Sketch showing relations of uteri, male tube, œsophagus and nerve cord.

Fig. 5.—Portion of proboscis (diagrammatic).

Fig. 6.—T.S. proboscis.

Fig. 7.—Rectum and anal funnels.

Plate x.

Fig. 8.—T.S. body wall of female.

Fig. 9.—Body showing male tube, two parts of a uterus, two intestinal loops, and the siphon.

Fig. 10.—Part of intestinal wall with associated siphonal folds with which the siphon becomes subsequently connected.

Fig. 11.—As in Fig. 10, but showing the siphon in process of fusion with the siphonal folds.

Fig. 12.—Uterus, side view, diagrammatic.

Figs. 13, 14.—Two views of posterior nephridial tubes.

Fig. 15.—Two sections across such tubes.

Fig. 16*a*, *b*, *c*, *d*, *e*.—Successive stages in the development of the ovum; *c* shows section through stage *b*.

Fig. 17.—Developing sperms.

Plate xi.

Fig. 18.—T.S. androecium and associated structures (female body wall, uterus, nerve).

Fig. 19.—T.S. androecium and male.

Fig. 20.—Oblique longitudinal section of body wall, androecium and male, showing mode of attachment of the posterior end of the male to the distal portion of the male tube.

Fig. 21.—Anterior end of male in oblique longitudinal section.

Fig. 22.—View of male in andrœcium, showing relation to body wall of female.

Fig. 23.—T.S. distal portion of male showing intimate relationship between that portion and the surrounding tissues of the andrœcium (oil immersion).

Fig. 24.—L.S. ditto (oil immersion).

Figs. 18 and 20 have been drawn to the same magnification: 19 and 21: 23 and 24.